

**REMARKS**

Claims 1-18 are pending in the application.

Of the above claims, 10-17 are withdrawn from consideration.

Claims 1-9 and 18 are rejected.

Claims 1-9 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Arai (JP 2003-041275A).

Claims 1-9 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ida (JP 2002-356686A).

Claims 1-9 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kato (JP 2003-055677A).

The Applicants traverse the rejections and request reconsideration.

***Claim Rejections Under 35 U.S.C. 103(a)***

**Rejection of Claims 1-9 and 18 as being unpatentable over Arai**

The general disclosure of Arai is related to making gas hydrate production more efficient wherein the gas-liquid (gas bubble-water) contact time is increased by forming a water flow counter currently to the gas bubbles rising. However, Arai does not disclose self-compression as required by the present invention nor its effect of micro bubbles (gas bubbles with diameter of 50μm or less) to change the conditions of gas hydrate generation.

In page 10, line 32-36 of the English translation, Arai discloses that the gas in the gas bubbles consumed as hydrate results in reduction of buoyancy of the gas bubbles, which then causes those gas bubbles to retain longer. The Applicants respectfully submit that in Arai's method, it is impossible to generate the micro bubbles having diameter of 50  $\mu\text{m}$  or less. Even if the gas-liquid contact time is extended by providing descending flow velocity, it is still believed to be impossible to collapse the gas bubbles within the system. On the other hand, in the present invention, gas bubbles with diameter of 50 $\mu\text{m}$  or less are generated, shrunk and collapsed in the reaction bath. At the moment of collapse of a gas bubble a very high pressure (infinite pressure in principle) is generated (Fig. 3 of the present Specification). As shown in Fig. 6, even though temperature and pressure conditions are initially set to generate a gas bubble of Point A, the gas bubble goes through the transition from A to B and then to C due to the changes inside and around the gas bubble. As a result, hydrate nucleation is forced to take place in a very efficient way. But in Arai's method, a gas bubble only stays at Point A. Arai only discloses about increasing the efficiency of hydrate at Point A. Therefore, no self-compression, and more importantly, no hydrated nuclei are generated.

The Examiner contends in item 9 on page 4 that patentability cannot be established by reciting relative sizes unless such size difference would result in new or unexpected results. The Applicants respectfully submit that, as described in detail above, the size difference and the conditions related to therein result in the unexpected generation of hydrated nuclei. Therefore, the size difference contributes to the invention in a significant way.

In other words, the elements recited in the claim, lead to a more than predictable result of generating hydrated nuclei as required by the US Supreme Courts decision in *KSR v Teleflex*.

In relation to claim 3, the Examiner incorrectly contends that the ascending rate of bubbles would necessarily depend on the size of the bubbles. The Applicants measured the relationship between diameter of gas bubbles and ascent velocity beforehand and provided a method to identify a gas bubble with diameter of 50 $\mu$ m or less. As shown in Fig. 2, a gas bubble with diameter of 50 $\mu$ m or less rises up approximately 1mm per second. As shown in Fig. 3, this gas bubble shrinks by dissolving the gas therein within the system to cause the ascent velocity to decrease. The ascent velocity of a gas bubble with diameter of 20 $\mu$ m is 200 $\mu$ m or less per second. In page 10, line 23 of English translation, Arai presents an example of downflow to promote gas dissolution with velocity of 0.1-3m per minute. The downflow velocity of the example is at least around 1.6mm per second, therefore the gas bubbles with diameter of 50 $\mu$ m or less are likely to be discharged from the lower part of the reaction bath. Clearly, this would not result in self-compression or generation of hydrated nuclei. In the present invention, it is very important that the gas bubbles collapse in the water, and when gas bubbles become 10 $\mu$ m or less in diameter they almost come to a standstill. Therefore, the generation of downflow that Arai describes is not believed to be relevant or correct.

In relation to claims 8 and 9, the Examiner contends that the bubbles are generated by a swirling two-pe flow process and are generated by a “bell” shaped bubble generator. The Applicants respectfully submit that arguably, with Arai’s technique, the bell shape is obtainable but the gas bubbles with diameter of 50 $\mu$ m or less cannot be generated.

Rejection of Claims 1-9 and 18 as being unpatentable over Ida

Ida generally discloses making gas hydrate production more efficient by dividing the production process into three phases – 1) micro bubble production phase, 2) gas dissolution phase and 3) gas hydrate production phase. However, Ida does not disclose self-compression effect on micro bubbles (gas bubbles with diameter of 50  $\mu\text{m}$  or less) or its use in gas hydrate generation.

In page 4, line 23-38 of English translation, Ida describes that the gas hydrate production process is divided into three phases, which has been suggested to solve the problem of the hydrate adhering to the porous plate, blocking the pores in the previous method. In page 7, line 10-20 of English translation, Ida uses the term “a fine bubble”, by which, we believe, he simply describes a known concept that the smaller a gas bubble is, the easier a gas therein dissolves. Ida’s line mixer in Fig. 2 does not provide a high rotating flow due to the impact caused by the obstacle 15, and thus gas bubbles with diameter of 50 $\mu\text{m}$  or less cannot be generated. As to the temperature and pressure, Ida only discloses the conditions of gas hydrate generation. In other words, Ida does not disclose self-compression of microbubbles or generation of hydrated nuclei as a result.

Rejection of Claims 1-9 and 18 as being unpatentable over Kato

Kato is generally related to generation of hydrate particles in different sizes by using gas bubbles in different sizes. However, as with the other references, Kato does not disclose the concept self-compression effect of micro bubbles (gas bubbles with diameter of 50  $\mu\text{m}$  or less) to generate hydrate nuclei.

Specifically, on page 6, line 14-44 of the English translation, Kato only describes that different-sized hydrate particles can be generated by changing the diameter of the gas bubbles. On the other hand, the present invention generates hydrate nuclei by using self-compression on micro bubbles having diameter of 50  $\mu\text{m}$  or less. The Applicants respectfully submit that using Kato's techniques, it is impossible to obtain the micro bubbles having diameter of 50  $\mu\text{m}$  or less. As to the temperature and pressure conditions, Kato simply mention the conditions of gas hydrate generation. Arai, Ida and Kato's methods require a supercooling condition of at least 4 degree centigrade, which is stronger than the equilibrium conditions, in order to generate gas hydrate. In the present invention, gas bubbles with diameter of 50 $\mu\text{m}$  or less are generated, shrunk and collapsed in the reaction bath as shown in Fig. 6, so that the aforementioned supercooling condition is not required to generate gas hydrate.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

**AMENDMENT UNDER 37 C.F.R. § 1.111**  
U.S. Appln. No.: 10/790,716

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The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

/Chidambaram.S.Iyer/

SUGHRUE MION, PLLC  
Telephone: (202) 293-7060  
Facsimile: (202) 293-7860

WASHINGTON OFFICE

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CUSTOMER NUMBER

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Chid S. Iyer  
Registration No. 43,355

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